Space Weather Technical Forecast

Issued on Tuesday, 13 September 2022 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms days 2 and 4. M-class flares considered likely. Ongoing Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a M1.7 flare observed at 12/2345 UTC. There are four notable sunspots on the disk. AR3098 in the northwest quadrant remains the largest and most complex spot, with a delta region in the centre portion of the spot. AR3101 in the far northwest is also large, but as it is close to the northwest limb, detailed analysis is difficult. AR3100, is elongated but only has one significant spot. The remaining significant region, Ex-3088 has rotated onto the southeast limb and appears to be a large spot which may turn out to be a leader portion to a more complex region. The remaining numbered regions are all simple and relatively benign. A filament eruption and subsequent CME from the vicinity of AR3098 appears to have resulted in a proton enhancement in the near Earth environment. This will be fully analysed when sufficient imagery becomes available.

Solar Wind / Geomagnetic Activity: The solar wind speed at L1 has followed a declining trend, with winds at background levels. Density was generally weak but briefly moderate with a peak of 17 ppcc at 12/1439 UTC. The total magnetic field strength was generally weak, with the north-south component switching from mainly negative to mainly positive. Phi angle was entirely positive (away from the Sun). Geomagnetic activity was initially Unsettled, but became Quiet from 12/0900 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, gradually rose to around 6 pfu by 12/1405 UTC the declined back to around 2 pfu by the end of the period. This is likely due to the forecast effects of a filament eruption on 11 September.

High energy electron flux varied from moderate to high. The corresponding 24-hour electron fluence remained above Active (1e8 integrated pfu) with a flat then declining trend, resulting in a 13/0000 UTC observed value of 1.61e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to increase from Low levels through the forecast period. M-class flares are considered likely with a very slight chance of X-class flares from three or four sunspot regions.

Solar Wind / Geomagnetic Activity: A CME which was observed leaving the Sun on 11 September may arrive at Earth on 13 or 14 September, although confidence is low. CH23/- may become geoeffective on day 4 (16th), perhaps bringing elevated solar wind speeds. Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 2 (14th) and day 4 (16th), due to the risk of a CME arrival, then the arrival of CH23/-, although the forecast is low confidence.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels, but with a very slight chance of exceeding the threshold, due to the increased sunspot complexity and recent CME

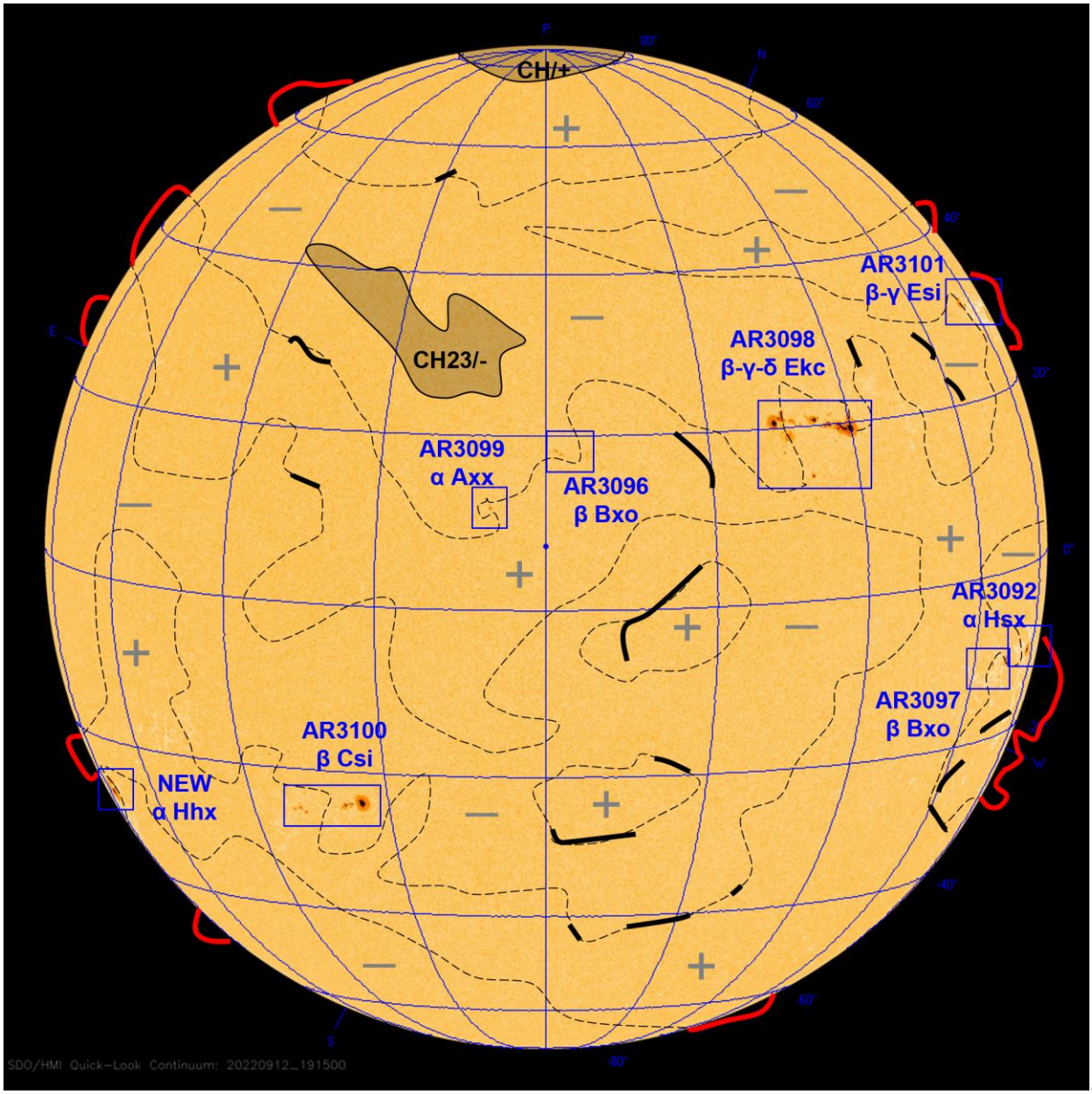
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

observations.

The high energy (greater than 2 MeV) electron flux is currently fluctuating between High and Moderate levels, and is Likely to remain so until midweek UTC, whereupon a combination of any fast wind increase may act to redistribute electrons. The corresponding 24-hour fluence is expected to see only a gradual ebb at first in the period, but is Expected to remain above Active (1e8 integrated pfu) until midweek, with a Chance of survival should geomagnetic activity not materialise.

Figure 1. Solar Analysis Valid 12/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

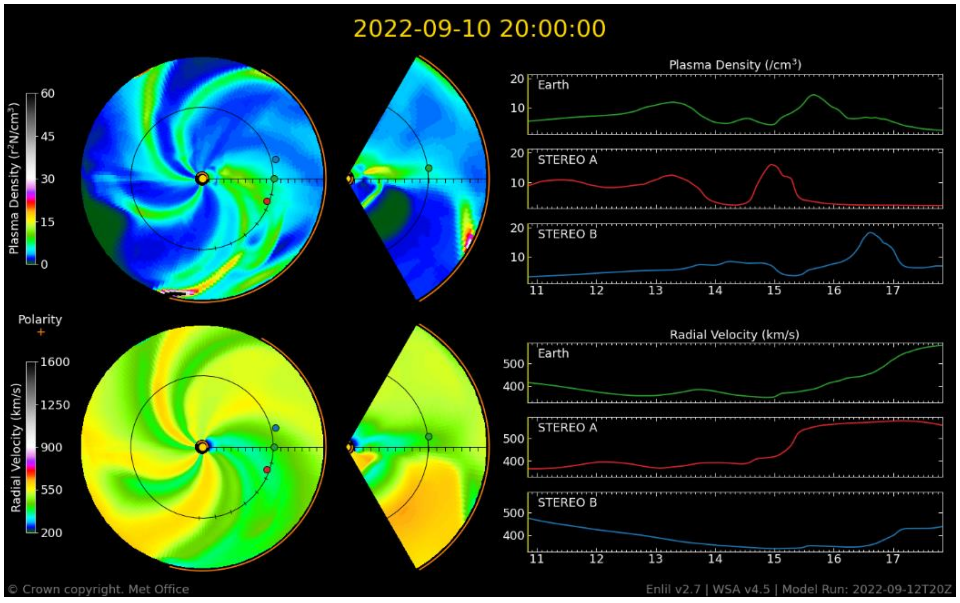
A filament eruption was observed leaving the north centre of the Sun around 11/1200UTC. STEREO A imagery although unclear indicates that a potentially Earth-directed CME has been emitted. The presumption of a CME however is supported by a sudden increase in the proton flux subsequent to the filament eruption, suggesting a 'snowplough' effect of proton enhancement ahead of a CME. In the absence of a sufficient analysis an estimate of a three day transit time would allow for an arrival on either late on 13 September or during 14 September, with a risk of G1/Minor Storms, although the forecast of arrival time or potential impacts are low probability.

Otherwise coronal hole 22 was a weak feature which appears to have closed, with no significant impact expected on solar wind speeds. The high speed stream from coronal hole 23 is then due to connect with Earth on day 4 (16th), though due to its negative polarity as we approach the autumn equinox, significant geomagnetic activity is thought to be unlikley.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 2 (14th) and day 4 (16th), due to the risk of a CME arrival, then the arrival of CH23/-, although the forecast is low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: ENLIL showing possible enhancements this coming week, note no CME analysis present from CME on 11th.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

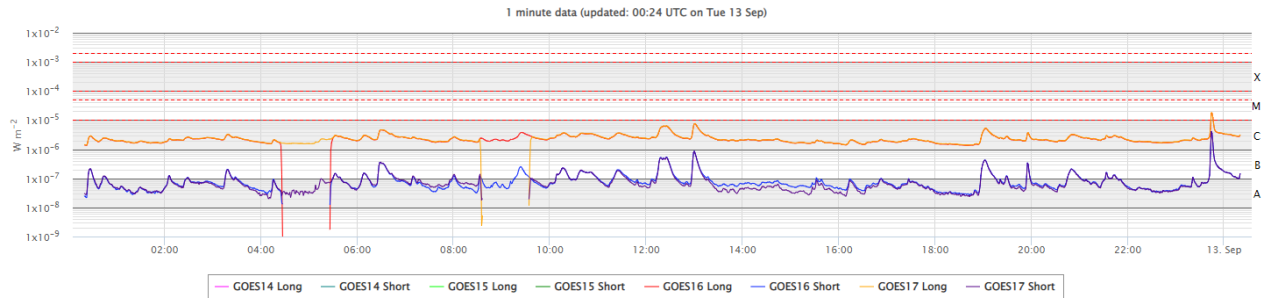
Radio Blackouts - X-Ray Flares:

The most significant sunspot region on the disc is AR3098 (Ekc/βγδ) which despite being classified as a delta spot, has not produced any significant flares. The region however may have been responsible for a CME eruption on 11 September, so carries an enhanced flare risk. AR3100 (Csi/β) on the northwest limb and AR3101 (Esi/βγ) towards the southeast limb are both showing signs of development, but neither has produced significant activity. There is also the risk of enhanced activity from ex-3088 which has recently begun appearing around the southeast limb. The remaining regions are either weak, stable, or relatively inactive.

Solar activity is expected to be mainly Low, but with an increased risk of M-class and X-class flaring due to the evolution of the three most significant sunspots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: Xray trace past 24 hours



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

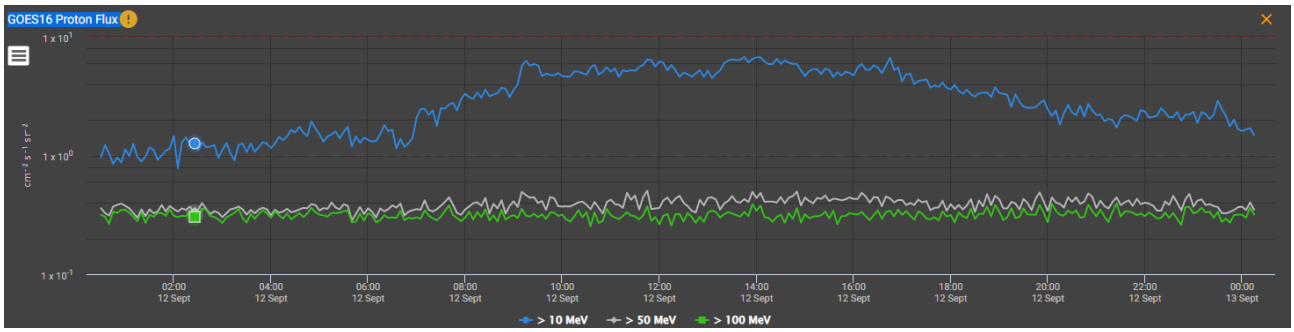
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) has undergone a marked enhancement over the last 24 hours. This may be due to a CME on the eastern limb or the filament eruption from the vicinity of AR3098 and subsequent proton enhancements ahead of the features.

Protons have now peaked, the risk of the S1 threshold being reached has now likely passed.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton trace past 24 hours.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

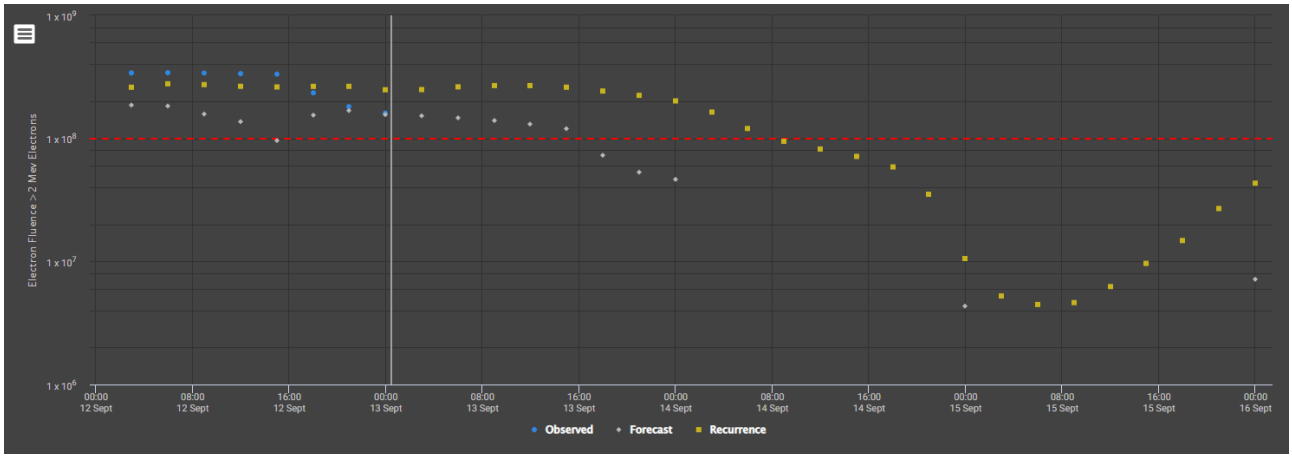
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux has varied between moderate and high levels through the last 24 hours, though some additions could be due to proton contamination. Otherwise, the diurnal peaks are expected to slowly fall as the radiation in the belts slowly dissipate as the solar wind eases. A potential CME arrival on either 13th or 14th September may lead to further losses due to geomagnetic enhancements, with a chance of a subsequent increase due to the injection of CME particles into the belts. A further variable is the possible arrival of CH23/- on 16th September, leading to another possible electron count reduction.

Electron fluence values are expected to follow a declining trend through the next four days, with low confidence toward the end of the period due to possible geomagnetic activity from CMEs and Coronal Hole HSS.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	50	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: REFM electron fluence obersavtions, foreacst and recurrance.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.